



White Paper

Intel® Xeon® processor

IT Infrastructure

Server Consolidation

Consolidation Strategies for Intel® Processor-based Servers

**Achieving Better Datacenter Flexibility and
Cost-effectiveness with Intel® Virtualization Technology**

Tens of thousands of businesses are using virtualization software to consolidate multiple operating systems and applications on Intel® processor-based servers. In the process, they are simplifying their datacenters, improving utilization, reducing total costs, improving security, and accelerating new system and application deployments. Learn about today's leading options and about critical new developments, such as Intel® Virtualization Technology, that are delivering better value today, and laying a foundation for future innovation.

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Executive Summary

Over the past 5 years, virtualization software running on Intel® processor-based servers has transformed the economics of server consolidation. IT organizations no longer have to balance the benefits of consolidation against the cost and risk of high-end RISC and UNIX implementations. Instead, they can achieve 10, 20 or even 30 to one consolidation ratios on Intel-based servers using mature, enterprise-proven solutions.¹ This has eliminated the traditional barriers to consolidation, helping IT organizations achieve better ROI and faster payback, with less need for specialized skill sets.

Although most organizations find there is a learning curve in moving to a virtualized environment, the benefits can be substantial, including lower datacenter costs, faster provisioning, improved management, simplified development environments, flexible fail-over and affordable business continuity. Because of these advantages, tens of thousands of businesses are consolidating their server infrastructures to improve efficiency and free up resources for new projects and for ongoing security and compliance initiatives.

To help IT organizations achieve more and faster payback, Intel is delivering optimized hardware support that magnifies the value of leading virtualization software solutions, such as VMware ESX Server*, Microsoft Virtual Server 2005* and Xen*.

- **Intel® Virtualization Technology** provides built-in hardware support that improves security, robustness and interoperability. Many core virtualization processes are performed in silicon, which simplifies software solutions and provides better fault and virus containment.
- **Dual-core, 64-bit Intel® processors** boost server performance and capacity, so more applications can be consolidated on smaller and more power-efficient systems.
- **The advanced RAS capabilities** of Intel processor-based servers help to improve server uptime and manageability, a critical advantage for businesses running multiple applications on a single server.

Consolidation on virtual servers has gone from a niche market to a massive industry migration that is affecting businesses of all sizes and across all industries. For most companies, the question is not whether to virtualize their server infrastructure, but which solutions to use. This paper discusses today's leading options, and describes some of the trends and developments that will continue to transform data-center operations in the years ahead.

¹ A number of VMware case studies document consolidation ratios as high as 30-to-1. For one example, see "QUALCOMM Lowers TCO Using VMware ESX Server and VirtualCenter;" www.vmware.com/customers/stories/qualcomm.html

High Value through Affordable Consolidation

Over the years, businesses have watched their data-centers expand to include hundreds or even thousands of systems running diverse operating systems and applications. As server numbers have grown, so has the cost of operations, including people, space, power and cooling.² Server consolidation is a key strategy for reducing these costs and today's virtualization software solutions make it easy to run multiple applications safely and securely on a single Intel processor-based server. Companies are using virtualization software and associated management applications to:

- Carve each physical server into as many as 30 virtual servers, each capable of hosting its own OS and application stack (Figure 1).³

- Deploy and manage physical and virtual servers efficiently from a common interface.
- Allocate server resources (CPU, memory and I/O) dynamically, and move running applications, workloads and sessions very quickly from one virtual server to another. Initially this capability was used for zero-downtime maintenance. It is now beginning to be used as a way of automatically provisioning new capacity when a system fails or workloads threaten to exceed existing resources.

Of course, planning is important in a successful consolidation project. For most organizations, virtualization involves new products and technologies, as well as new IT procedures and usage models. Decision-making policies often have to change as well, since individual physical servers may be shared among multiple business units.

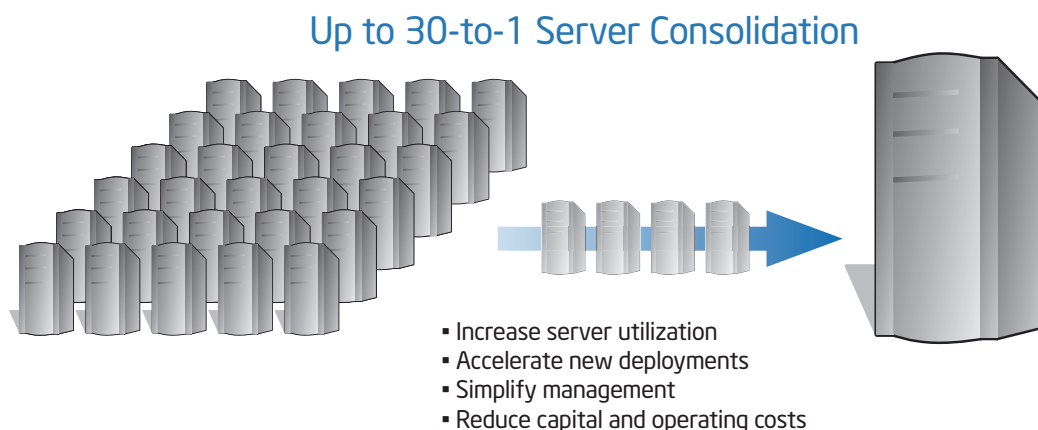


Figure 1. With virtualization software running on Intel® processor-based servers, businesses can consolidate diverse operating systems and applications safely and securely. Each physical server can be carved into as many as 30 virtual servers to simplify infrastructure, improve agility and reduce total costs.

² A recent article in CIO Insight Magazine cited typical server maintenance costs based on an IDC report: "According to a recent report by IDC, the labor required to maintain a single small application server can cost between \$500 and \$3,000 per month in a production environment—and that figure excludes costs associated with backup and recovery, network connectivity, power and air conditioning." Source: "Virtualization Can Save Departments, Not Just Servers," by Karen S. Henrie, CIO Insight, January 6, 2006.

³ Actual consolidation ratios depend on workloads, system capacity and IT policies. According to IDC, most businesses are deploying 2- to 4-processor servers with 4 or fewer virtual partitions per server. (For details see the IDC report, "Server Virtualization 2005: Understanding the Adoption of Virtualized Server Resources:" www.idc.com/getdoc.jsp?containerId=prUS00259905) However, many businesses are deploying larger servers and using them to consolidate large numbers of applications. For examples, see the VMware Web site: www.vmware.com/customers/stories

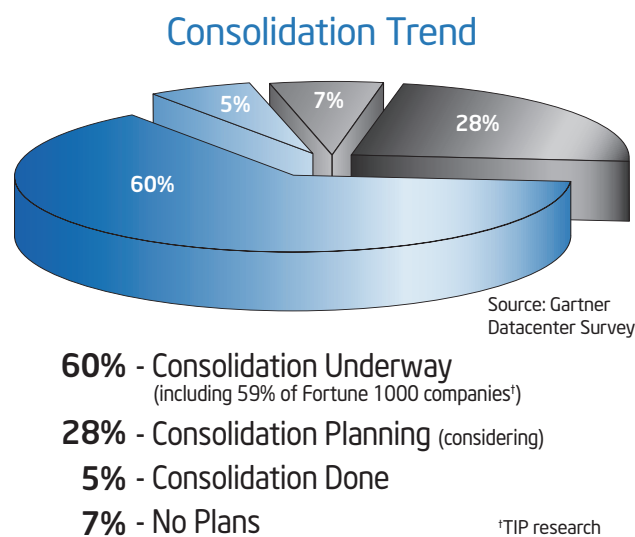


Figure 2. According to Gartner, 60 percent of surveyed businesses are already using virtualization technology to consolidate their servers, and another 28 percent are planning or considering consolidation.

However, the potential cost savings are substantial. A study conducted by VMware documents the following customer savings through virtualization and consolidation:

- Hardware: 28-53 percent savings
- Operations: 72-79 percent savings
- Total: 29-64 percent savings.⁴

Not surprisingly, such savings have led to rapid adoption. Gartner reports that 60 percent of surveyed companies are in the process of consolidating their infrastructure; and 28 percent are planning or considering consolidation (Figure 2).⁵ In short, consolidation through virtualization has already become a mainstream IT strategy that delivers fundamental advantages in datacenter efficiency.

Today's Leading Solutions

The following are a few of the most important software options for virtualization and consolidation on Intel processor-based servers.

VMware ESX Server*

- Market-leading solution for Intel® Xeon® processor-based servers⁶
- Broad OS support for consolidation in heterogeneous environments
- Robust management tools for datacenter optimization

VMware was the first software vendor in this market and now offers a comprehensive and mature package of virtualization solutions and related management tools. VMware products can be used to consolidate a broad range of operating systems, which provides considerable flexibility in heterogeneous environments. The products also enable very flexible and dynamic allocation of processing, memory and I/O resources. Up to four processors can be assigned to an individual virtual machine, so many mid-tier and back-end applications can be run in a virtual environment.

VMware has rapidly evolved its management tools to optimize the value of its virtual machine technology. Recent innovations include the ability to dynamically manage server resources not only within individual physical servers, but across multiple physical systems, so a failed or overloaded virtual machine can be automatically transferred to a new virtual machine on the same or a larger physical server without downtime. With these capabilities, VMware is pushing the boundaries of datacenter management, providing centralized tools that enable flexible and precise control of workloads and physical resources.

For more information, visit the VMware Web site: www.vmware.com

⁴ The VMware study analyzes TCO for 5 companies that are using VMware across a range of different applications. It provides quantitative results, as well as a TCO model that IT organizations can use to assess the value of virtualization in their own environments. For details, see "Total Cost of Ownership Reduction with VMware:" www.vmware.com/vmwarestore/newstore/tco_login.jsp

⁵ Source: *Server Consolidation is Still a Major Goal, but Not Just for Cost Cutting*, by John R. Phelps, Gartner Research, March 1, 2005.

⁶ Source: "Virtualize Your Datacenter," an Intel and VMware solution brief: [ftp://download.intel.com/business/bss/products/server/virtualize_datacenter.pdf](http://download.intel.com/business/bss/products/server/virtualize_datacenter.pdf)

*Consolidation in Action using VMware ESX Server**

Mechanics Bank

- 12:1 consolidation ratio
- Five year “hard” savings of \$1.5 - \$1.7M
- Payback in less than 10 months

“We can deliver a server, a virtual machine, to a business unit in an hour or two instead of having to order physical hardware, wait for it to arrive, and then set it up.”

— Richard Lewis, vice president of IT, Mechanics Bank

One of the largest banks headquartered in the San Francisco Bay Area was looking for a way to achieve three major IT goals: cut costs, establish an effective disaster recovery solution, and streamline its test and development environment. Working with VMware, the company achieved all three objectives via a consolidation project that will pay for itself in less than 10 months.

Of their 105 servers, 102 were consolidated onto just 8 servers: 2 new 4-way dual-core Intel® Xeon® processor MP-based systems, and 6 repurposed 2-way servers. Based on the results, the company projects five-year “hard” savings of \$1.5 - \$1.7M and full payback in less than 10 months. They also have a simpler and more agile datacenter, and can respond much faster to business unit requests.

For more information, read the VMware case study, which focuses on the pre-deployment assessment process:
www.vmware.com/customers/stories/mechanics_bank.html

Microsoft Virtual Server*

- A cost-effective high availability solution
- Tight integration with Microsoft’s solution stack
- Optimized for Intel Xeon processor-based servers.

Microsoft’s Virtual Server 2005 R2 is a cost-effective server-virtualization solution engineered specifically for the Windows Server System* Platform. Virtual Server 2005 R2 currently runs on both 32- and 64-bit versions of the Windows Server* 2003 operating system. Most operating systems run well on Virtual Server, and Microsoft has recently announced it will provide support for specific distributions of Linux running as guest operating systems.

A key advantage of Virtual Server 2005 R2 is that it supports high availability through clustering. Both virtual and physical machines can be clustered, which provides a solution for both planned and unplanned downtime. Virtual Server 2005 R2 is also tightly integrated with the Microsoft Windows Server 2003 operating system, Microsoft Operations Manager* (a MOM service pack is available now), Systems Management Server (SMS) and Active Directory. Microsoft offers extensive management and migration tools, along with integrated support and a favorable pricing and licensing structure that can significantly reduce total costs in production environments.

Microsoft is clearly committed to virtualization, and the company has announced plans to build virtualization capabilities directly into its operating systems in the Longhorn Server wave, while providing a clear migration path for current users. Virtualization is also a foundational component of its Dynamic Systems Initiative, which is focused on providing a comprehensive approach to reducing datacenter costs and improving business agility. For companies interested in a cost-effective server virtualization solution for a Windows environment, this solution is well worth exploring, and can be expected to provide increasing value in the years ahead.

For more information, visit the Microsoft Web site:

www.microsoft.com/windowsserversystem/virtualserver/default.aspx

Xen*

- Open source virtualization software
- Designed to support high-end datacenter solutions
- Supports both Intel Xeon and Intel® Itanium® 2 processor-based servers

“Novell and Intel share a common vision for what virtualization will mean to customers. Our implementation of Xen 3.0, developed in collaboration with Novell’s Virtual Technology team, will allow customers tremendous flexibility in deploying virtualized environments to harness the full potential of their Intel-based hardware.”

— Jeffrey Jaffe, executive vice president and chief technology officer, Novell

Xen virtualization software is an open source solution developed by the Linux community. Xen initially required that guest operating systems be modified to run successfully (this is known as paravirtualization). However, the latest release (Xen 3.0) includes support for Intel® Virtualization Technology, which enables Xen to support unmodified guest operating systems, including Windows.⁷

⁷ Be aware that the technical ability to run unmodified operating systems and applications in a virtual environment does not mean the software vendor will support its products under those conditions. For definitive information on OS and application support, check with the appropriate vendors.

*Consolidation in Action using Microsoft Virtual Server 2005****AtlantiCare**

- 16:1 consolidation ratio
- Reduced capital and operating costs
- Faster new deployments and simplified migrations

"I estimate that we can host more than 100 virtual machines on these three 8-way boxes. That will cover our expansion needs for a long time."

– Roger Vann, technical project manager, AtlantiCare

A prominent New Jersey healthcare organization needed more datacenter capacity for new applications and to support a major migration to Microsoft operating systems and applications (during the migration, the new versions would have to run side by side with production systems). Rather than upgrade its facilities, the company consolidated multiple applications onto two 8-way Intel® Xeon® processor MP-based servers, using Microsoft Virtual Server. *"We are currently running 25 virtual machines on one physical device and 8 on another without coming close to maxing out the CPU resources,"* says Roger Vann, technical project manager for AtlantiCare.

IT staff found the solution easy to learn, and very powerful. They not only avoided the cost and disruption of a data-center expansion, but have also reduced hardware, electrical power and server management overhead; can deploy a new virtual machine in minutes; and have plenty of head-room to support new applications and growing workloads. According to Vann, *"When we need a server, it's there. The IT staff can respond to customer requests much faster, and, ultimately, AtlantiCare can respond to opportunities faster."*

For more information, read the Microsoft case study:

<http://members.microsoft.com/CustomerEvidence/Search/EvidenceDetails.aspx?EvidenceID=3561&LanguageID=1>

Xen 3.0 supports up to 32 processors per virtual machine and live transfers of running applications. It also runs on both Intel Xeon and Intel Itanium 2 processor-based systems. Given the high-end scalability and availability of Itanium 2-based servers, this will allow Linux-based virtualization to move further up in the datacenter, providing the scalability and availability needed to consolidate enterprise-critical applications.

Xen is a relatively new technology, but industry support and customer interest is strong, deployment-ready solutions are beginning to emerge and rapid advances can be expected. As noted by one analyst, *"... the combination of open source and server virtualization is a double win."*⁸

- The open source community has already begun integrating Xen into the Linux OS kernel.
- Red Hat and Novell have integrated Xen into the free versions of their Linux operating systems, and are working to include it in their supported versions.
- At least one vendor, XenSource (www.XenSource.com), now offers management tools and support for Xen deployments. According to Simon Crosby, XenSource's chief technology officer, *"We are working extensively with the open source community and with many leading hardware and software vendors to provide robust support for deploying, managing and optimizing server virtualization solutions using Xen virtualization software. We believe this will dramatically accelerate the adoption of Xen-based solutions, and deliver substantial benefits to our customers."*

For the latest information on Xen development, visit:

www.cl.cam.ac.uk/Research/SG/netos/xen/

And More

Virtualization on Intel® architecture has attracted enormous interest from both vendors and customers. Existing solutions are advancing rapidly and many vendors are developing competing or complementary products. It will be important to monitor these developments to understand the full range of options going forward. The following highlights just a few of the many available options that may deliver better or complementary value in selected environments.

- **Vendor-Specific Virtualization Solutions:** Vendors such as Bull, Egnera, Fujitsu, Fujitsu-Siemens, Hitachi, HP, and Unisys offer sophisticated virtualization and consolidation capabilities that are tightly integrated into their own operating environments. These solutions tend to support very high levels of availability, scalability and manageability, without the high cost of proprietary RISC-based systems.
- **SWSoft:** SWSoft's Virtuozzo runs in standard Linux and Windows environments. It provides a low-overhead, high-performance virtualization solution with a comprehensive set of management tools designed for enterprise customers and service providers.

⁸ Source: "Will Linux take the lead in server virtualization," by Neil McAllister, *Infoworld*, December 12, 2005: www.infoworld.com/article/05/12/12/500Popenent_1.html

- **Virtual Iron:** Virtual Iron products deliver many of the advantages of the virtualization solutions discussed above. They also enable a single virtual server to span multiple physical servers. In combination with Virtual Iron's high-availability options, this enables even the most demanding, mission-critical applications to be supported on affordable, Intel processor-based servers.
- **Others:** The market segment for virtualization is growing rapidly, and both long-established vendors and new startup companies have products available or in development.

Better Value with Advanced Server Technologies

"Robust VMware solutions combined with VT (Intel® Virtualization Technology) and dual-core technology stand to drive virtualization even more mainstream."

— Brian Byun, vice president of strategic alliances, VMware

Virtualization and consolidation place greater demands on server platforms, requiring better performance, scalability and availability to maintain appropriate service levels for multiple business applications. Intel is delivering a number of advanced server technologies that deliver clear advantages in consolidated environments.

Intel® Virtualization Technology

Intel® Virtualization Technology provides fundamental architectural support for today's software-only virtualization solutions, and helps to improve robustness, security and interoperability. Many core virtualization processes are handled in silicon, rather than software, which simplifies implementation, improves legacy OS support, and provides better isolation between virtual partitions.

Intel Virtualization Technology is already supported in Xen. VMware and Microsoft will support it in future releases (expected in 2006). Integrated hardware support will help to simplify and extend each of these solutions, and will provide the foundation for a number of critical advances. For example, it will enable all three solutions to support a wider variety of unmodified guest operating systems, including 64-bit versions.⁹ Many other vendors are also taking advantage of Intel Virtualization Technology to improve their solutions, and leading server vendors have voiced strong support for these developments (see the sidebar, "Broad Support for Intel Virtualization Technology").

Intel Virtualization Technology is already integrated into dual-core Intel® Xeon® processors that were introduced in 2005, and can be activated with a BIOS update.¹⁰ It will be supported natively in next-generation dual-core Intel Xeon and Intel® Itanium® 2 processors, both of which are expected to be available in 2006. Intel is also working on next-generation virtualization technologies that are expected to accelerate performance and deliver comparable advantages for memory and I/O virtualization (Figure 3). Through these efforts, Intel will continue to provide industry-leading hardware support that improves the value of current virtualization solutions and lays the groundwork for ongoing innovation.

For more information about Intel Virtualization Technology, see the Intel white paper: "Enhanced Virtualization on Intel Architecture:" www.intel.com/business/bss/products/server/virtualization_wppdf

Intel® Virtualization Technology Evolution

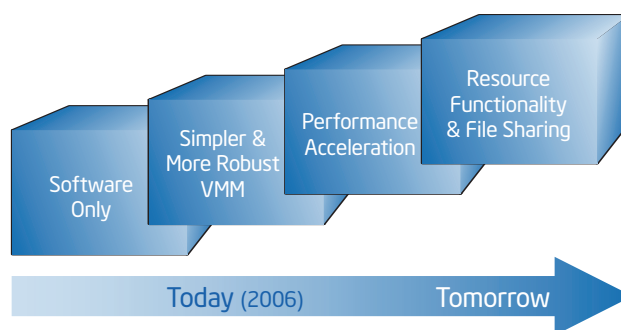


Figure 3. Intel® Virtualization Technology enables simpler and more robust virtualization and consolidation today, and will evolve rapidly to deliver increasing benefits.

⁹ "For Windows and other guests that are unaware of Xen, the hardware virtualization of Intel VT, combined with paravirtualizing device drivers in Windows, allows Xen to achieve the same high level of performance as virtualized Linux guests." Source: XenSource Web site: www.xensource.com/products/xen/faqs.html

¹⁰ See your server vendor for information on updating your BIOS to support Intel® Virtualization Technology on existing dual-core Intel® Xeon® processor-based servers.

Broad Support for Intel® Virtualization Technology

With support for Intel® Virtualization Technology already included in Xen*, and coming soon in software products from VMware, Microsoft and many others, leading server vendors see it as an important component of their next-generation solutions.

- **Dell:** *"Dell is partnering with other industry leaders to develop a standards-based approach to the virtual server ecosystem. Intel Virtualization Technology is a key enabler and will help increase the value of industry-standard servers for our customers."*
- Paul Gottsegen, vice president of worldwide enterprise marketing at Dell
- **Hewlett Packard:** *"HP virtualization solutions help customers lower costs by optimizing utilization while increasing agility. The combination of Intel VT [Intel® Virtualization Technology] and HP virtualization management tools will drive increasing adoption of virtualization on ProLiant* servers. With a broad base of VT-enabled servers already shipped, HP can help many customers implement both 32-bit and 64-bit virtual machines on their existing systems."*
- Paul Miller, vice president of marketing for Industry-Standard Servers and the HP BladeSystem* at Hewlett-Packard
- **IBM:** *"Intel® Virtualization Technology and IBM's X3 Architecture-based* family of servers are raising the bar for virtualization on Intel-based servers. The field-proven reliability of our scalable servers and new 64-bit guest OS support available through VMware Server allow the broadest range of customers to gain first-hand experience with virtualized applications."*
- Leo Suarez, vice president and business line executive for IBM xSeries.

Multi-core Processors and 64-bits

Multi-core, 64-bit Intel processors are ideal for virtualized servers running multiple operating systems and applications. Today's dual-core Intel processors provide up to twice the processing resources

of comparable single-core processors, so a server can handle twice as many simultaneous software tasks.¹¹ This not only provides more processing resources at lower cost, but enables very granular allocation of those resources across multiple virtual machines. IT organizations can consolidate more applications per server, to achieve better ROI and to further reduce their operational costs.

The synergy between multi-core processors and virtualization is mutual. Many legacy applications are single threaded, so they cannot take full advantage of multiple cores. By consolidating these single-threaded applications onto a single server, businesses can make better use of today's most powerful Intel processor-based servers. Of course, if performance is critical for a particular application, businesses should consider optimizing the code for multi-threaded throughput. They can then assign as many cores to the application as needed to achieve their performance goals. The Intel® Software Network offers extensive tools, information and support that can help businesses simplify and accelerate their code optimization efforts.¹²

The 64-bit capabilities of Intel server processors deliver comparable advantages in consolidated environments. Multiple applications and operating systems can place heavy demands on system memory, and traditional 32-bit processors can only directly address up to about 4 gigabits. As a result, data may have to be shuttled back and forth between storage and memory, a time-intensive process that can lead to latencies and performance bottlenecks. In contrast, 64-bit Intel Xeon processors can address up to one terabyte of memory; and Intel Itanium 2 processors up to one petabyte (1,000 terabytes). Servers based on these processors can be configured with plenty of memory to efficiently support multiple data-intensive applications.

Advanced RAS Capabilities

In consolidated environments, a failed server can bring down multiple business applications, so high reliability, availability and serviceability (RAS) are critical. By delivering leading RAS features on industry-standard servers, Intel enables IT organizations to consolidate critical applications with greater confidence and at lower cost. Intel Xeon processor-based servers offer great flexibility and affordability for extensive consolidation of mainstream applications. Intel Itanium 2 processor-based systems take RAS to an even higher level, providing support that is comparable or superior to high-end RISC-based solutions. For more information about the RAS capabilities of Intel processor-based servers, see the Intel white paper: "Reliability, Availability and Serviceability for the Always-On Enterprise."

www.intel.com/technology/magazine/Computing/Intel_RAS_WP_0805.pdf

¹¹ Many Intel processors also support Hyper-Threading Technology, which enables each core to handle two simultaneous software threads. According to *Tom's Hardware*: "Our tests show that Intel's Hyper Threading processors can provide a substantial performance boost, even if the number of active VMs exceeds the logical HT processor count." Source: "AMD and Intel Servers Compete For Ultimate Virtuality," by Arild Skullerud and Patrick Schmid, *Tom's Hardware*, December 29, 2005.

¹² Intel has thousands of software engineers working with leading software vendors, corporate developers and the open source community to optimize software for the latest Intel processor-based servers. For information and resources, visit the Intel® Software Network: www.intel.com/software

Choosing the Best Server for the Job

Consolidation can have a major impact on server purchasing criteria. When only a single application is run per server, a small, 2-processor system may deliver the best overall value. However, if multiple applications are run per server, a large, multi-processor system may deliver better value, since the higher capital cost is likely to be more than offset by the associated reductions in total space, power, cooling and management costs.

IT organizations should therefore take a fresh look at the relative ROI for 2-way, 4-way and larger servers as they consolidate. They may also want to consider configuring their systems with dual-core processors, larger cache, more memory and more advanced RAS features (redundant power supplies, hot-plug components, etc.), all of which can help to deliver better value by enabling higher consolidation ratios.

Intel architecture supports a range of options to meet specific consolidation goals.

- **Intel Xeon processor-based servers for better utilization:**
Consolidation of multiple applications onto 2-way Intel Xeon processor-based servers can be a simple, cost-effective way to increase utilization and reduce server sprawl.
- **Intel Xeon processor MP-based servers for enhanced consolidation:** These 4-way and larger systems support heavier workloads and higher consolidation ratios, which can help to deliver substantially better returns on consolidation projects.
- **Intel Itanium 2-based servers for high-end solutions:**
Itanium 2-based servers deliver the scalability and availability needed for consolidation of back-end enterprise applications, and for very large numbers of mid-tier or front-end applications. A wide range of virtualization solutions are currently available, including Xen, SWSoft's Virtuozzo* and vendor-specific solutions from leading server manufacturer's, such as Bull, Egenera, Fujitsu, Fujitsu-Siemens, Hitachi, HP, and Unisys.
- **Blade servers:** All the servers mentioned above are available in blade configurations that can deliver outstanding value in consolidated environments. Dozens of high-density physical servers can be hosted in a single blade frame. Power, cooling, cabling, networking and storage resources are consolidated and shared, which can lead to substantial reductions in space, management and utility costs. Virtualization software can be used to further increase utilization and efficiency by enabling each blade to host multiple operating systems and applications.

*Consolidation in Action using the Egenera BladeFrame**

A Top-Five U.S. Telecommunications Company

- Eliminate 75 percent of all servers
- Reduce software licenses by 80 percent
- Save more than \$50M over five years

The Internet boom led to major growth in the telecommunications industry, with comparable expansion in applications, services and computing infrastructures. With the economic downturn that followed, there was tremendous pressure to reduce costs, but the diversity and complexity of existing systems often made that a tough challenge.

One major U.S. telecommunications company answered the challenge by turning to the Linux* operating system running on the Egenera BladeFrame*. A rigorous pre-deployment evaluation showed that the solution would not only save money in relation to existing systems, but would be more cost-effective than running the same software on standard rack-mount servers. The blade solution would support large scale consolidation of Unix servers; reduce space, power and cooling costs; and deliver high-end management capabilities that would simplify and improve administration, workload management and fail-over solutions. Altogether, the company concluded that migrating to Linux on the Egenera BladeFrame would help them reduce their server count by 75 percent, and save more than \$50M over a five-year period.

For more information, read the Egenera case study:
www.egenera.com/pdf/casestudy_telco_2.pdf

Ongoing Innovation

Cost-effective consolidation is just one of the advantages offered by virtualization software running on Intel processor-based servers. Virtualization is a truly transformative technology and its impact on business computing solutions will continue to increase. The following are just a few examples of key developments that will impact the way companies deploy and manage business applications.

- **Software in pre-configured, pre-tuned virtual machines**—With this approach, an application can be downloaded and installed as easily as transferring a file. Several leading virtualization and application software vendors already offer applications in this format.

- **Faster performance**—Most of today's virtualization solutions add a layer of software, which introduces processing overhead that can slow application performance. However, some vendors are introducing innovations that actually accelerate application performance in virtual containers (see the sidebar, "Faster Performance in Virtual Machines").
- **Integrated security**—Today's virtualization software enables substantial hardware consolidation, but does not reduce the number of operating systems that must be managed and patched. Future advances can be expected to increase security at the hypervisor level (the layer of software between the server and guest operating systems). With sufficiently strong security, businesses may be able to avoid patching legacy OS's altogether.
- **Utility-based (on-demand) computing**—Ultimately, virtualization will require the entire industry to take a fresh look at software licensing paradigms. In time, it will likely lead to utility computing models, in which customers pay based on actual usage, rather than the number of processors running the application or the number of licensed users.
- **IT outsourcing**—Virtualization makes it easier for service providers to support multiple customers on a single server, so they can optimize utilization and efficiency while meeting stringent availability and security requirements. Utility computing will add to these advantages, enabling very flexible and cost-effective outsourcing models.
- **The automated datacenter**—By abstracting hardware and software resources, virtualization provides the foundation for comprehensive datacenter automation. A number of major vendors are moving toward this model, while many others are developing pieces that will be part of larger solutions. As one example, Cisco has developed a network based approach to virtualization that creates a high-speed 10Gbps InfiniBand* fabric and maps physical servers with software images stored on a storage area network.¹³ This enables rapid and centralized provisioning of processing and I/O resources. As virtualization evolves across all computing resources (processing, memory, I/O, storage, networking, etc.), datacenters will continue to become more modular, flexible, scalable, manageable and resilient.

Faster Performance in Virtual Machines

"Intel® Virtualization Technology is providing us with a foundation for dramatically improving application performance and management. We are beginning with Java support, but intend to ultimately extend this approach to encompass the blended enterprise."

— Guy Churchward, general manager of BEA's Java Runtime Products Group

BEA is taking advantage of Intel® Virtualization Technology to deliver two major improvements for Java applications in BEA environments in the first half of 2006.

- **Twice the Performance**—Today's virtualization software solutions introduce processing overhead, which tends to slow application performance. By running Java application stacks in dedicated virtual servers (with the operating system in a separate virtual server), BEA is reducing OS overhead to help improve Java application performance by as much as 100 percent (based on early prototype results).
- **10X Faster Virtual Machine Transfers**—Today's virtualization solutions can transfer very large applications and data sets in seconds. By orchestrating the process to focus on critical components, BEA is helping reduce that time to milliseconds. This enables near-instant migrations and is intended to provide businesses with the highest levels of availability and control for mission-critical workloads.

¹³ For more information, see the Cisco Web site: <http://cisco.com/en/US/products/ps6429/index.html>

Conclusion

With today's virtualization software running on Intel processor-based servers, the barriers to server consolidation have been largely eliminated. As a result, tens of thousands of companies are consolidating their infrastructures to drive down costs and improve efficiency. Some of today's leading software and server vendors are delivering solutions today, and the large, cumulative investment will continue to drive rapid advances and increasingly competitive pricing structures.

By delivering leading support at the hardware level, Intel is helping to improve performance, scalability, availability and interoperability in today's virtualized and consolidated datacenters.

- **Intel Virtualization Technology** provides silicon-level support for today's virtualization software solutions, to make them more robust, secure, supportable and interoperable.
- **Dual-core, 64-bit Intel processors** improve performance and increase scalability in consolidated environments.
- **Intel's advanced server RAS capabilities** help IT organizations meet the high uptime requirements for servers hosting multiple, business-critical applications.

This support can help IT organization realize better ROI and faster payback as they virtualize and consolidate their datacenters. It can also help them lay a flexible, standards-based foundation for future advances. Intel is focused on delivering increasing hardware support for consolidation and virtualization, and businesses can count on Intel processor-based servers to keep them in the forefront of innovation, so they can continue to drive down their total costs and create a more flexible and manageable IT infrastructure.

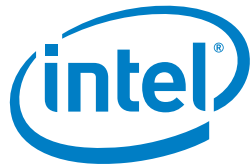
Learn More

For comprehensive information about virtualization and consolidation on Intel processor-based servers, including additional white papers, solution briefs, case studies, tutorials and technical specifications, visit the Intel Web site: www.intel.com/business/bss/products/server/virtualization.htm

Appendix A: Best Practice Recommendations

1. **If you haven't begun consolidating on virtualized servers, now is the time to explore your options.** The benefits are proven, and virtualization is seeing exceptionally rapid adoption.
2. **Evaluate your applications for potential consolidation.** Legacy applications running on older operating systems are a common first target, but virtualization and consolidation are moving rapidly toward the mid-tier and back-end of the datacenter.
3. **Understand the differences between various virtualization solutions.** Cost, functionality and performance vary considerably and value will differ depending on your IT and business environment.
4. **Look closely at the licensing and support policies of your software vendors.** Licensing and support policies are in flux with respect to both virtualization and multi-core processors, and both issues can strongly impact the ROI of a consolidation project.
5. **Start small.** Virtualization and consolidation involve new products, technologies, usage models and IT procedures, so a small pilot deployment is recommended before consolidating on a broad scale.
6. **Work with business units to manage expectations.** Business decision-makers may be reluctant to run their applications on shared physical servers until they understand the benefits and safeguards.
7. **Beware of "virtual sprawl."** Virtual servers are extremely easy to deploy and provision, but don't abandon all constraint. Every new virtual server introduces new OS and application instances, which can increase licensing, patching and general management costs.
8. **Consider blades as a complementary consolidation strategy.** Blade servers help to consolidate and optimize physical infrastructure, while virtualization software optimizes the use of those physical resources. The combination can be especially effective.
9. **Integrate server consolidation with a broader consolidation strategy.** Consolidation of facilities, storage and data are equally important, and provide a solid foundation for application consolidation on virtual servers.
10. **Develop a framework for continuous consolidation:** Products and technologies are changing rapidly. Success will require careful planning, a long-term strategy, and an approach that comprehends benefits, risks and costs. According to Gartner, *"Without a framework for continuous enterprise consolidation, IT organizations will struggle to develop rapidly enough to cost-effectively meet the demands placed on them by business unit and external partners, and therefore risk budget cuts or inappropriate full-scale outsourcing (0.8 probability)."*¹⁴

¹⁴ Source: "Adopt a Framework for Continuous Enterprise IT Consolidation," by Rakesh Kumar, Gartner, Inc., November 24, 2005.



www.intel.com/info/virtualization

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